Localization of gravitational energy in ENU model and its consequences

Jozef Sima, Miroslav Sukenik and Julius Vanko

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The contribution provides the starting points and background of the model of Expansive Nondecelerative Universe (ENU), manifests the advantage of exploitation of Vaidya metrics for the localization and quantization of gravitational energy, and offers four examples of application of the ENU model, namely energy of cosmic background radiation, energy of Z and W bosons acting in weak interactions, hyperfine splitting observed for hydrogen 1s orbital. Moreover, time evolution of vacuum permitivity and permeability is predicted.

1 Section

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Localization of gravitational energy in ENU model and its consequences

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Abstract. The contribution provides the starting points and background of the model of Expansive Nondecelerative Universe (ENU), manifests the advantage of exploitation of Vaidya metrics for the localization and quantization of gravitational energy, and offers four examples of application of the ENU model, namely energy of cosmic background radiation, energy of Z and W bosons acting in weak interactions, hyperfine splitting observed for hydrogen 1s orbital. Moreover, time evolution of vacuum permitivity and permeability is predicted.

I. Theoretical backround

Due to the simultaneous creation of both the matter and gravitational energy (having the identical absolute values but differing in the sign of the values) the total energy of the Universe is equal to zero in the model of Expansive Nondecelerative Universe (ENU) and thus one of the fundamental requirement

of the Universe evolution [1] is fulfilled. It has been evidenced [2] that such a Universe can expand by the velocity of light c and it therefore holds

$$a = c.t_c = \frac{2G.M_U}{c^2} \qquad (1)$$

where a is the gauge factor (at present a 1.3 x 10^{26} m), $t_c$is the cosmological time, M_U is the mass of the Universe (it approaches at present 8.6 x 10^{52} kg).

In the ENU model, due to the matter creation the Vaidya metrics [3] must be used which enables to localize the gravitational energy. For weak fields Tolman's relation [4]

$$\varepsilon_g = -\frac{R.c^4}{8\pi.G} = -\frac{3m.c^2}{4\pi a.r^2} \qquad (2)$$

can be applied in which ε_g is the density of the gravitational energy induced by a body with the mass m in the distance r, R denotes the scalar curvature. It should be pointed out that contrary to the more frequently used Schwarzschild metrics (in which ε_g= 0 outside a body, and $R = 0$), in the Vaidya metrics R $\neq$0 and ε_g may thus be quantified and localized also outside a body. It has been shown [4] that at the same time it must hold

$$\varepsilon_g = \frac{3E_g}{4\pi.\lambda^3} \qquad (3)$$

where E_g is the quantum of the gravitational energy, the corresponding Compton wavelength can be expressed as

$$\lambda = \frac{\hbar.c}{E_g} \qquad (4)$$

Substitution of (4) into (3) and comparison of (2) and (3) leads to

$$|E_g| = \left(\frac{m.\hbar^3.c^5}{a.r^2}\right)^{1/4} \qquad (5)$$

in which $E_g$denotes the quantum of the gravitational energy induced by a body with the mass $m$in the distance r.

The validity of (5) was tested both in the field of macrosystems and microworld. Application of equation (5) allowed us to derive in an independent way the Hawking's relation for black hole evaporation and explain the presence of some peaks in low-temperature far-infrared and Raman spectra of several compounds [4].

Some of the further verifications and applications of relation (5) are given in the following parts.

II. Energy of cosmic background radiation

From the beginning to the end of radiation era, the Universe was in thermodynamic equilibrium. Based on the above postulate it can be supposed that the energy of a photon of the cosmic background radiation equaled to the energy of a gravitational quantum, i.e.

$$k.T = |E_g| = \left(\frac{m.\hbar^3.c^5}{a.r^2}\right)^{1/4} \qquad (6)$$

When taking m in (6) as the mass of the Universe, M_U

$$M_U = \frac{a.c^2}{2G} \qquad (7)$$

and r as the gauge factor a

$$r = a \qquad (8)$$

a well-known formula [5]

$$k.T \cong \left(\frac{\hbar^3.c^5}{2G.t_c^2}\right)^{1/4} \qquad (9)$$

is obtained, however, when comparing to [5], the mode of its derivation is independent. The present consistency might be evaluated as an evidence of justification of the ENU model.

III. Weak interactions

In our previous paper [6] the mass of Z and W bosons was derived stemming from the energy density. As it will be shown in the following, an identical relationship can be obtained using equation (5), i.e. stemming from gravitational energy quantization. Let us substitute m by the limiting mass [6]

$m = \frac{a.\hbar^2}{g_F}$ (10)

where g_F is the Fermi constant, and express r as the Comptom wavelength of the vector bosons Z and W possessing the mass m_{ZW}

$r = \frac{\hbar}{m_{ZW}.c}$ (11)

In such a case, from (5), (10) and (11) we obtain

$|E_g| = m_{ZW}.c^2$ (12)

if the known relation

$m_{ZW}^2 \cong \frac{\hbar^3}{g_F.c}$ (13)

was applied.

IV. Hyperfine structure of the hydrogen atom K-level

Equation (5) can be exploited to an independent prediction of the value of hyperfine structure E_{HF}observed in the spectra of hydrogen atom (experimental value for the electron occupying H1s orbital is $E_{HF} = 1420$ MHz). Suppose, the energy of the hyperfine splitting induced in the hydrogen atom K-level by the proton magnetic momentum is identical to the energy given by equation (5). Such an identity may be taken as a condition of the stability of the hydrogen atom. When putting the mass of electron m_e (9.109 x 10^{-31} kg) and the Bohr radius of H1s orbital

$r \cong 52.9 \times 10^{-12} m$ (14)

into (5), the energy value

$E_{HF} \cong 2400 MHz$ (15)

is obtained. This value is 1.7 times higher than the experimental value and thus closer to it than that of calculated one using a commonly applied simplified equation (16)

$E_{HF} \cong \frac{I_{H1s}.\alpha^2.m_e}{m_p}$ (16)

in which I_{H1s} is the hydrogen atom ionization energy (13.6 eV) and $\alpha$is the constant of hyperfine splitting.

V. Time evolution of the vacuum permitivity

The constant of hyperfine structure α is defined as

$\alpha = \frac{e^2}{4\pi.\epsilon_o.\hbar.c}$ (17)

At the beginning of separation of electromagnetic interactions the equation

$\alpha = 1$ (18)

had to be valid. When substituting

$r = \frac{\hbar}{m_e.c.\alpha}$ (19)

into the left side of (21) and

$I_{H1s} \cong m_e.c^2.\alpha^2$ (20)

into the right side of (21)

$$\left(\frac{m_e.\hbar^3.c^5}{a.r^2}\right)^{1/4} \cong I_{H1s}.\alpha^2.\frac{m_e}{m_p} \qquad (21)$$

the dependence

$$\alpha \approx a^{-1/14} \qquad (22)$$

appears. Two conclusions may be derived from the above relationships. The first one is that equation (18) relates to the time

$$t \cong 10^{-10}s \qquad (23)$$

which is just the time in which the weak and electromagnetic interactions were separated. The second consequence relates to (22), i.e. the time evolution of the constant of hyperfine splitting. Since the velocity of light, electronic charge and Planck constant are considered to be time independent quantities, time evolution of the Universe (e.g. changes in its mass and, in turn, also in charge and electrostatic field density) and the gradual increase of the gauge factor may be reflected in a very slow change in the vacuum permitivity ε_o (an electric property) and vacuum permeability μ_o (a magnetic property).

Conclusions

1.Increase in the gauge factor has several consequences which are to be unveiled and explained in the future. One of them is a gradual decrease in the hyperfine splitting constant which can be related to a time-increasing of vacuum permitivity and time-decreasing of vacuum permeability.

2.Capability of localization of the gravitational energy within ENU is a challenge for answering the questions such as unification of all four fundamental physical interactions, stability or invariability of some physical quantities and "constants".

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